A Listing of Indicators and Indicators Architecture Drawn from CMARP Working Papers

(Note: Indicators were taken from specirfic indicators sections in the working papers with minor editing. No attempt was made to interpret monitoring constituents/parameters as potential indicators.)

Task 3B, Element 1a—Bay-Delta Fish X-2 Relationships

- *The degree to which the research questions are answered* (administrative)

Task 3B, Element 1c—Hydrodynamics and Sediment Transport

- *Aggregate single station currents, depths and limited concentration/number density data used to infer fluxes as a composite hydrodynamics indicator*
- *Inferred mass fluxes (DAYFLOW and QWEST) as indicators of net river flow out of the Delta and into the Bay and flow across the Delta towards pumping*
- *X2 as an indicator of the overall salinity structure of the Bay/Delta*
- *Water levels at the Golden Gate as a general indicator of the tidal hydrodynamic forcing of the system*

Task 3B, Elements 1d and 2a.i—System Productivity—Small Invertebrates

Indicators not identified.

Task 3B, Elements 1e and 1h—System Productivity—Fishes and Large Invertebrates and Striped Bass

- Abundance, distribution, body burdens and diets for Delta, brackish water, and polyhaline food chains including planktivores, bottom feeders, pelagic predators, benthos, plankton, epibenthos
- Physiological effects indicators (e.g., disease, feeding and reproductive success) for fishes in the food chains above

Task 3B, Elements 1f and 2a.ii—Contaminants

Indicators not identified.

Task 3B, Element 1g—Delta Smelt

- *Comparative statistics derived from abundance and distribution indices of the delta smelt population before and after CALFED actions*

Task 3B, Elements 1i.ii and 1i.iii—Salmon San Joaquin and Sacramento

Indicators not identified.

Task 3B, Element 1j—Resident Fish

- *Index of biotic integrity specific to resident fish*
- *Percentage of native fish and percentage of intolerant fish as measures of the response of the fish community to environmental conditions*
- *Percentage of omnivorous fish*
- *Percentage of fish with external anomalies*
- *Geographic distribution of various fish communities (e.g., foothill community) displayed as maps as summary information*

Task 3B, Element 1k—Steelhead

Indicators not identified.

Task 3B, Element 1l—Fluvial Geomorphology and Riparian Systems

Indicators not identified.

Task 3B, Element 1m—Benthic Macroinvertebrates

- *Taxa richness as an indicator of community diversity (higher numbers represent a more diverse benthic community)*
- *Shannon Diversity Index (numeric indicator of community health based on species diversity)*
- *EPT Taxa (total number of distinct taxa within the pollution sensitive insect Orders Ephemeroptera, Plecoptera and Trichoptera*
- *EPT Index (total number of individuals in the Orders Ephemeroptera, Plecoptera and Trichoptera relative to the total number of individuals in the sample)*
- *Modified Hilsenhoff Biotic Index (HBI) (numeric values increase with increasing community tolerance to disturbance)*
- *Percent Dominant Taxon (PDT) (proportion of individuals in the most dominant taxon relative to the total number of organisms in the sample as an indicator of community balance with higher values representing stronger environmental disturbance)*

Task 3B, Element 2a.iii—Delta Region, Drinking Water Quality

- *Primary indicators of concern for drinking water quality: organic carbon, bromide, pathogens, nutrients, salinity and TDS, turbidity, and pH. (Salinity, nutrients and turbidity are also of concern to agricultural and environmental uses.)*
- *Contaminants such as trace metals, organics, and pesticides regulated under the Safe Drinking Water Act and/or listed on the Drinking Water Contaminant Candidate List*
- *Stressors such as water diversions, dams, reservoirs, and weirs; levees, bridges and bank protection; and dredging and sediment disposal posing significant impacts on drinking water quality through changes in contaminant concentrations in source*

waters. For example, water diversions may result in increased salinity in source waters; dredging may result in increased turbidity, metals, and organics/pesticides; and bridge construction activity may result in increased turbidity due to increased soil erosion.

Task 3B, Element2b—Water Quality—Sacramento Region

- Ambient toxicity
- Fish tissue concentration of specific contaminants
- Dissolved trace metal concentrations in water
- Organophosphate concentrations in water
- Benthic invertebrate community indices in wadable streams

Task 3B, Element 2c—Water Quality in the San Joaquin Basin

- *Various water column concentrations, biological resources, sediment quality, and streamflow*

Task 3B, Element 3—Water Transfers

- *Streamflow—quantity, quality, and temperature*
- *Surface water reservoirs—storage, quality, and temperature*
- *Groundwater—levels, quality, and temperature*
- *Subsidence—land surface altitude, groundwater levels, compaction*
- *Delta hydrology/operations—water supply contract deliveries, transfers by agencies within the projects, operational commitments to the fisheries agencies, makeup pumping, deliveries for critical needs, power operations and costs, hydrology, biological opinions and take, export limits and flow requirements, outages*
- *Socio-economic effects—cropping pattern and acreage, number and size of farms, value of agricultural output, agricultural employment, rural business sales and employment, population, county tax collection and expenditures, labor force and unemployment*

Task 3B, Element 4—Water Use Efficiency—Conservation

- *Agricultural Water Use and Conservation—irrigation efficiency and distribution uniformity formulas to estimate on-farm, district and regional efficiencies supported by re-use data and associated environmental and third-party effects of re-use data*
- *Urban Water Conservation—gross per capita water use*

Task 3B, Element 4—Water Use Efficiency—Water Recycling

Indicators not identified.

Task 3B, Element 5—Watershed Management

Indicators not identified.

Task 3B, Element 6—Delta Levees

Indicators not identified.

Task 3C—A Process for Data Management

No indicators component.

Task 3D—A Process for Data Analysis and Reporting

The following text was extracted from the DART report section II entitled, "Use indicators to assess the state of the environment and determine if calfed program goals and objectives are being met."

Purpose of utilizing indicators

The development and analysis of indicators for trends is anticipated to be a major function of CMARP in the future. An indicator is defined as

"a parameter (i.e., a measured or observed property), or some value derived from parameters (e.g., via an index or model), which provides managerially significant information about patterns or trends (changes) in the state of the environment, in human activities that affect or are affected by the environment, or about relationships among such variables. As defined here, indicators include geographic (spatially referenced) information, and information used in environmental management at any scale, i.e., not just for high-level policy-makers." [United States Environmental Protection Agency, April 1995, Conceptual Framework to Support Development and Use of Environmental Information in Decision Making: Document Number 239-R-95-012, Washington, DC]

Indicators are needed for the following three purposes in CALFED:

1) State Monitoring – to determine the state of the environment, delta levees, water quality, and water availability, etc.

Monitoring must be conducted to determine the current state of valued elements of the environment, delta levees, water quality, water availability, etc. These valued elements have already been largely identified in the various CALFED program documents. CMARP must work with CALFED to reach agreement on what these valued elements are and develop indicators to measure their status.

2) Programmatic Monitoring – to determine if CALFED goals and objectives are being met.

In order to improve the state of the environment, delta levees, water quality and water availability, CALFED has formed specific program goals and objectives and developed action plans. CMARP must develop specific indicators to determine whether these program goals and objectives are being met.

3) Project Monitoring – to determine if specific individual CALFED project goals and objectives, regulation compliance objectives and mitigation objectives are being met.

In order to accomplish CALFED's stated program goals and objectives, individual projects will be initiated. These individual projects will each need to be monitored for

a) Implementation monitoring to determine how far a project has been implemented

b) Effectiveness monitoring to determine how effective an action has been in meeting its stated objectives.

c) Compliance monitoring to make sure laws and regulations are being complied with

d) Mitigation monitoring to determine that project effects in one area are being compensated for in another area.

Some CALFED projects are small, such as pilot habitat restoration projects, whereas other projects may be large, such as building canals and re-routing of water flow.

Development and evaluation of indicators

Indicators will be identified and developed for state monitoring, programmatic monitoring and project monitoring. For each indicator, the following general process of indicator development is anticipated.

Indicator Identification – The CALFED ERP Indicators group and the CMARP work teams have been involved in identifying valued elements and associated parameters and indicators which need to be measured to evaluate ecosystem health and determine if CALFED program objectives are being met. This work needs to be further prioritized and specific indicators will need to be developed from the work team products. Project level indicators and key public indicators will both need to be developed in the future. The steps involved in indicator identification include:

a. Determine element to be monitored

b. Determine indicator capable of monitoring status of element

c. Determine specific objective that indicator is being used to measure

d. Determine how indicator will determine if objective is met: detect trends, detect if thresholds or triggers are exceeded, determine effect of a programmatic action, develop background information, etc.

e. Determine type of monitoring: trend monitoring, before impact vs. after impact, control site vs. impact site, Before/After/Control/Impact, mitigation monitoring, compliance monitoring, and background monitoring.

Indicator specification – Once indicators have been identified, the specific details of how they will be measured and evaluated need to be developed. This will probably require a series of workshops involving experts in these areas. The steps which need to occur are:

a. develop the methodology for how indicator will be calculated from existing or new monitoring information – for example, how is the indicator of X2 position calculated?

Where are measurements taken, how are they combined together, how is the X2 position be compared with other years (will there be a standard "wet", "dry", "normal" baseline developed?).
b. determine thresholds/trigger levels for claiming that a change has occurred – for example, how much of a change in X2 position is of concern to program managers? At what point do they wish to be notified that a problem may be developing?
c. determine number and frequency of sampling needed to detect change at the required sensitivity level – How many samples and in what locations are needed to detect the change in X2 within a timeframe that program managers can react?

Development of Background information – Once indicators have actually been fully developed, background data will need to be gathered depending on the purpose of the indicator. This will involve gathering of historical data, development of baseline information, advising on control site development where possible for programmatic actions, and advising on pilot monitoring program development and evaluating the results.

Analysis & Evaluation of Indicators – Once the required background information has been gathered, and CALFED actions have been initiated, the indicators will be analyzed for trends, differences between before CALFED action vs. after action and control site vs. impact site, and for exceeding thresholds or triggers. The reporting rate will depend on the needs of the program managers and the stakeholder groups as discussed in the reporting section. For example, the water quality indicators could be reported monthly on a web page together with threshold levels and targets. Or the position of X2 could be reported daily combined with a comparison of "normal" X2 position for that type of water year.

Status of indicator development

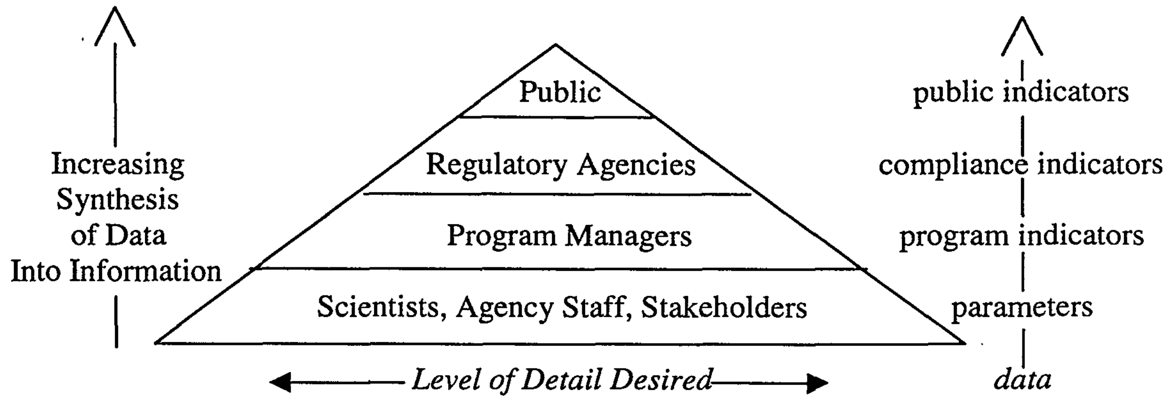
At present only the "Indicator Identification" step has been accomplished to any degree for programmatic level and state of the environment indicators. Project level indicators will be developed at a later date when specific projects have been approved with the exception of Category III projects which are currently being assessed. The CALFED ERP Indicators group has specifically identified state of the environment indicators for the Ecosystem Restoration Plan. The CMARP work teams have developed lists of monitoring parameters they recommend for inclusion in a CMARP monitoring program. Some of these can be directly used as indicators whereas others will need further work to develop into indicators. The workteam monitoring parameters are a combination of status indicators and program indicators.

Audiences for indicator reporting

Four different audiences are anticipated to be receiving reports on the status of CALFED indicators and monitoring parameters: 1) the public, 2) CALFED program managers 3) regulators and 4) scientists, agency staff and stakeholders.

In general the level of detail desired by each group is expected to be different as follows:

Fig. 3



In most cases the indicators desired by the public will likely be a subset of indicators desired by program managers (e.g. number of spawning adult salmon returning in current year versus base year). However, some additional indicators may need to be developed which are easy for the public to relate to and understand even if their usefulness to scientists is low. For example an overall index of drinking water quality (poor ... high) may be desired which compiles information across the wide range of water quality measurements taken. Once the indicators needed for program managers have been identified, workshops can be held for the development of specific public indicators.

Analyze indicators relative to objectives and targets

CMARP will be responsible for making sure that indicators are analyzed for trends, before/after CALFED implementation comparisons, CALFED action versus control site comparisons, compliance monitoring, background monitoring, etc. Some of the information regarding CALFED indicators may be gleaned from existing agency reports. Where such information is sufficient for CALFED purposes, CMARP's role will involve collecting the proper reports and sorting out the relevant information. However, since most agencies conduct monitoring for their own purposes and goals, CMARP will need to conduct its own analyses for most of the indicators relative to CALFED goals and objectives.

Task 4—Design a CALFED Focused Research Program

No indicators component.

Task 5—Develop an Institutional Structure for CMARP

The following text was taken from the Task 5 report section entitled "responsiveness to management needs." The types of management needs to which the CMARP must respond include (1) support for decision-making in for urgent and short-term situations, (2) support for the adaptive management process, and (3) measurement of program.

3. <u>Measurement of program performance</u>. Numerous mechanisms will need to be set up

to measure performance of the CALFED programs. Some of these, including both the performance of individual projects (such as those currently funded under the Category III program) and the monitoring of overall system condition to detect trends and evaluate success will be the purview of CMARP.